The preparation of a modern computer science teacher with the help of resource-saving technologies and green IT implementation

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Abstract

The main trend of a modern education is the rational using of information resources in the educational programs implementation. In this regard, it is important to apply resource-saving (RST) and green IT (GIT) technologies in education. Green IT culture education should start at school, and universities should produce qualified teachers who are able to organize training using these technologies. However, there is a shortage of such teachers in schools and universities. The module "European resource-saving trends in Computer Science teacher training" was introduced into the educational curriculum of bachelors in order to solve this problem. It is necessary to use this module so that bachelors (future teachers of computer science) will be ready to apply and introduce methods of innovative training in schools based on GIT and RST. The following results have been achieved during the implementation of this project: a course of lectures and practical exercises on the declared module have been developed, remote module support and a virtual platform have been created. It promotes European traditions and experience in RST and GIT through the Internet. The novelty of the project implementation is the partnership activity of students and teachers with use of forums, online discussions, webinars, blogs, scientific consultations and joint publications.

1   Introduction

The problem of resource-saving is not new, it has remained relevant during the existence of mankind. Scientists around the world are trying to find the ways to solve it. Recently there are new concepts, technologies and activities that related to resource-saving activities, for example: technical, economic, scientific and information activities. Along with this, methods, processes, complexes of organizational and technical measures which are related to rational and economical using of resources are also considered. The adjective "green" is a fairly new term in combination with these areas of activity. It is accepted to understand as ecological, safe, economical. However, until recently the issue of formation of economic, information, legal cultures in combination with RST and GIT [1, 2] was not raised and was considered in the educational system. At the same time, the rational using of information resources in the implementation of educational programs has gradually become the main tendency of modern education. Thus, the strategy of the educational process transition and the management of education for new methods with using of RST and GIT is an urgent task.

In the world practice, resource conservation is viewed from different angles: as saving natural, energy, labor, financial, time, production, intellectual and other types of resources. Resource-saving are an actual problem and have a long history. Back in 1992, the Energy Star project was launched in the USA by the Environmental Protection Agency. The essence of it was to encourage voluntary energy efficiency trends in the development of monitors, climate control equipment and other products and technologies. Later Australia, Canada, Japan, New Zealand, Taiwan and the European Union joined this program.

Russia does not stand aside from this problem. Resource-saving is one of the priorities of the country's economy. The State Program "Energy Saving and Improving Energy Efficiency for the Period to 2020" [3] was accepted in Russia. Projects in this area are constantly being implemented in various regions of the country, for example:

- The Project "Resource-saving. Choosing the Future", Omsk [4] was aimed at raising the level of the population awareness in issues of efficient using of resources (water, energy, heat) in everyday life;

- The project "Resource-saving (Energy)", Moscow [5] was devoted to the formation of basic theoretical knowledge of resource-saving technologies in everyday life and school. This project is of particular importance because it is aimed at fostering a resource-saving culture among the young generation of Russia population.

The Tempus-Project "Fostering Innovations on Green Computing and Communications (GREENCO)" (the grant from the University of New Cassella, Great Britain) was successfully implemented in 2012-2016 in the North Caucasus Federal University. The project was devoted to the implementation of advanced technologies for resource-saving and energy efficiency in the IT-industry. There are other examples, such as, the TEMPUS-GREENCO Green Computing and Communication project was implemented in Ukraine. As a result, the two-volume edition of "Green IT Engineering", ed. Kharchenko V.S. was published in 2014. It contains lecture materials for master's, doctoral's courses and trainings. We have thoroughly studied the experience of implementing these projects and related materials. This experience has become valuable for our study.

The analysis of existing means of activity, the study of the advanced European countries experience in the field of resource saving formed the understanding that the education of GIT culture should start from school, and universities should produce qualified teachers who can organize teaching using resource-saving technologies. However, there are not enough such highly qualified teachers in educational organizations. Thus, despite the fact that many different projects of the resource-saving area have already been organized and conducted, it is a new direction and it is the subject of our research.

The aim of the research is to propose a strategy for introducing resource-saving technologies and green IT into the training of future teachers and for Russian education.

2   Main Part

2.1   Description of The Model of Preparing Students for Resource-Saving Activities

The project "European Trends in Resource-saving in Teacher Training for Informatics" (586905-EPP-1-2017-1-EN-EPPJMO-MODULE) began in 2017 at the North Caucasus Federal University with the support of the Erasmus + Program Foundation (Jean Monnet Foundation). This project is used to introduce a unique educational program in the process of training bachelors. The program is based on the best European experience in RST and GIT.

This project is directed at formation of abilities of the future teachers in the spheres of computer science to resource-saving activity, to introduction of educational innovative GIT and RST in schools. The developed author's model of the computer science future teachers preparation for resource-saving activities was presented in [6]. This model consists of several parts interrelated. It was the basis of the project (see Fig. 1).

The conceptual unit of the model contains:

- Requirements for the level of bachelor's training: the formation of willingness for resource-saving activities;

- Tasks that specify the goal in each individual case: the willingness to introduce innovative methods of learning in the educational process of the school on the ba-sis of GIT; willingness formation to use RST;

- Approaches: interdisciplinary, systemic and personal-activity, which create the most optimal conditions for achieving the goal;

- The principles of system, scientific, effectiveness, openness, consciousness and activity suitable for achieving the goal.

The content unit contains training components that provide scientific-pedagogical, psychological, methodological support to the educational process in various forms of presentation (information and reference materials and educational materials of the module, electronic resources, a virtual platform created for remote module support, etc.)

The organizational unit is the implementation of the function of the educational process managing. It represents the development of a set of methods, forms and tools that are modeled taking into account the conditions for organizing classrooms, extracurricular and independent work of students.

The technological unit includes the implementation of selected educational technologies. They help a student develop professionally, intellectually, emotionally and socially.

The technical unit is a means of teaching: software and hardware, devices, specialized simulators and computer modeling tools, automation of scientific research, extra-curricular and organizational-managerial activities, and computer communications [7].

The diagnostic unit contains pedagogical evaluation (knowledge control systems: rating, computer testing, portfolio, accumulation systems), levels, criteria and indices of competence of students, results (willingness to resource-saving activities [8]).

2.2 Module Presentation and Methods Description of Preparation for The Module

It should be noted that pedagogical education has been in the center of attention not only of higher education specialists, but also of the pedagogical community, both in Russia and abroad in recent years. Training a teacher for educational and productive pedagogical activity using new teaching technologies causes the greatest problems. In order to solve this problem, we must introduce innovative courses in the educational process.

Currently, the North-Caucasus Federal University prepares bachelors of pedagogical education on the profile "Computer Science and Information Technologies in Education". The module "European Trends in Resource-saving in the Teaching of Informatics Teachers" is being implemented within the framework of this educational program. Students learn European methods of innovative education based on GIT during classroom activities and independent work. They also study the possibilities of RST with the purpose of their application in educational activities.

The methodology of the project is to integrate the static and dynamic elements of the course into the learning process. The novelty of the project is the implementation of an individual approach to the formation of various components of willingness to resource-saving activities in future teachers. At the theoretical level, axiologic (the system of an individual values motivating a student for resource-saving activities) and cognitive (the system of necessary competences about the theoretical and methodological foundations of resource-saving) components of willingness are formed with the help of video lectures, webinars, online discussions. The practical work organized in the form of debates, discussions, round tables facilitates the acquisition of skills in resource-saving activities by students. In addition, the partnership activity of teachers and students in the form of project activities, forums, online discussions, webinars, blogs, scientific consultations and joint publications is a methodical novelty of the project.

2.3 Project Implementation Technologies

We relied on the accumulated world experience in education with the use of technologies for the implementation of the project. In general, the elements of online learning are used in the most leading foreign and Russian universities or "mixed education" is practiced. The list of IT-technologies used in education is constantly expanding, including through new social media and web 2.0 services. The number of implemented educational innovations is increasing (for example, mass free online courses). Significant experience in organizing distance learning and online courses has been accumulated in the world and in Russia. We believe that this experience will be useful in implementing the announced project.

The distance module support was established during the first year of the project implementation in the NCFU in Training Management System (https://el.ncfu.ru). Lectures and practicals for the module work are presented on the remote platform. This allows students not only listen theoretical materials and perform practical tasks of the module in classroom sessions, but independently remotely work with theory and practice and consolidate the acquired knowledge and skills.

The module includes lectures using various forms of training: multimedia technologies, interactive methods, discussions, reviews, videos. The lecture course introduces students to the European approach of resource-saving and green IT. It provides theoretical basis for understanding of resource-saving activities and forms a willingness to implement GIT into schools.

The following issues are discussed at the lectures: a review of EU legislation in the field of resource-saving and IT, the concept and classification of RST, European and Russian experience in resource-saving, energy saving technologies and world experience in energy saving, modern infocommunication and tablet technologies from the standpoint of RST, technical means for implementing resource-saving information processes, free software as a RST, electronic libraries and tablet technology as a re-source for the conservation of wood raw materials, GIT, cloud services as part of GIT, intellectual resources and its resource conservation through information technology and artificial intelligence, resources saving educational technologies.

The module provides practical classes for concepts that are more serious and obtaining additional skills for applying European methods of innovative learning based on green information technologies.

The cycle of practical classes allows:

- To get practical skills of resource-saving activities for future teachers of computer science;

- To form a willingness to introduce innovative methods of teaching in the educational process of the school on the basis of GIT;

- To get skills of RST applying. Practical work includes project research, business and educational games, discussions, case study, problem training, brainstorming, solving resource-saving problems, creating mental maps, etc. Practical work allows:

- To get skills of resource-saving activity through the use of the tablet and mobile technologies, electronic libraries;

- To study power consumption of information input and output devices and computer devices;

- To get an idea about cloud services as an element of GIT;

- To consider e-learning from the perspective of resource-saving educational technologies and analysis of the specifics of applying GIT in education.

Practical studies include the research of successful European and Russian projects implemented in the field of resource-saving.

Remote access to theoretical and practical material provides feedback to students in the form of questions and assignments on the subject of the module that students must complete and submit on a distance platform for evaluation by the teacher.

Summer intensity is carried out as an additional work on the project. The project allows students to strengthen the skills of application received in lecture and practical classes of RST and GIT. The summer intensity takes place in the format of research activities. The results of the research are the basis for the participation of students in international conferences, symposiums and forums on GIT and RST. Scientific publications of young researchers will be presented as a result at conferences. Master classes for students are organized by European experts who tell students about the possibilities of resource-saving applying in educational activities.

Practical skills, were acquired by students, will be applied in the training of schoolchildren in the summer IT-school and in pedagogical practice. Future teachers of computer science, working with schoolchildren in the IT-school, will be able to apply their experience in the field of RST and GIT, will carry out joint projects with schoolchildren, will organize round tables and discussions, will participate in webinars and teleconferences about resource-saving topics. Group research projects of students and schoolchildren will be presented as a results of the summer school. In the long term, the acquired competences can be applied by bachelors when writing scientific articles, bachelor's work or master's thesis. These skills will allow young teachers to introduce European methods of innovative education based on GIT into the educational process of schools, as well as to apply RST in their further professional activities, including with the goal of creating an international partnership.

A virtual platform for organizing of a distance information support of the educational process, as well as, access to all module materials and feedback to students is created within the module. The virtual platform of the module of pedagogical and methodological materials allows students to have online access 24/7 to all the teaching materials of the module, provides an opportunity to share the results of applied research and experimental teaching work for students and teachers on the topic's module. In the future, coordination of the work of thematic seminars, round tables, conferences on the project will be carried out on the platform. The platform will provide telecommunications support for the activities of the professionals network. In addition, the training materials for the project will be presented on the platform in electronic form (in English and Russian) in the future.

Thus, the virtual platform promotes the European traditions and experience of RST and GIT through the Internet. Module development is becoming available to the entire world. The virtual platform will allow widely distribute information among the Russian-speaking population, since, at the present time, such information about the European experience in the field of resource conservation is not enough. Unfortunately, RST are practically not used in Russian educational organizations.

3   Conclusion and Expected Results

The successful implementation of this project will contribute to an increase of the graduates number (bachelors of teacher education) who will receive special competencies in the field of resource-saving information technologies and will be able to apply advanced European experience of the green technologies using in their professional pedagogical activities.

Introduction of green technologies and world experience of resource-saving in educational organizations will lead to the resource-saving culture for the younger generation of Russia. Successful implementation of the project will help to increase the competitiveness of pedagogical education graduates, expand their mobility and orientation not only on the Russian, but also on the world labor market for further employment. At the present stage of economic relations development, one of the most important tasks is the maximum economy and rational use of all types of resources, further improvement of existing technologies and the rapid development of innovative RST, including, we believe, educational ones. Graduates will be ready to introduce educational programs that are competitive in the international market of educational services.

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The conceptual unit

The aim:

formation of bachelor's willingness for resource-saving activi-...

The tasks:

willingness to introduce innovative methods of teaching on the basis of green IT in the educational process of schools;

The approaches:
- interdisciplinary;
- system;
- personal.

The principles:
system, scientific, performance, openness, consciousness and activity

Activity of a teacher

Activity of a student

The content unit
Information and training materials, European experience, lecture and practical classes, virtual platform, etc.

The organization unit
(methods, forms, means)

The technical unit
(educational tools based on information techology)

The technological unit
(educational techologies)

The diagnostic unit

Monitoring

Reaction

The generated result
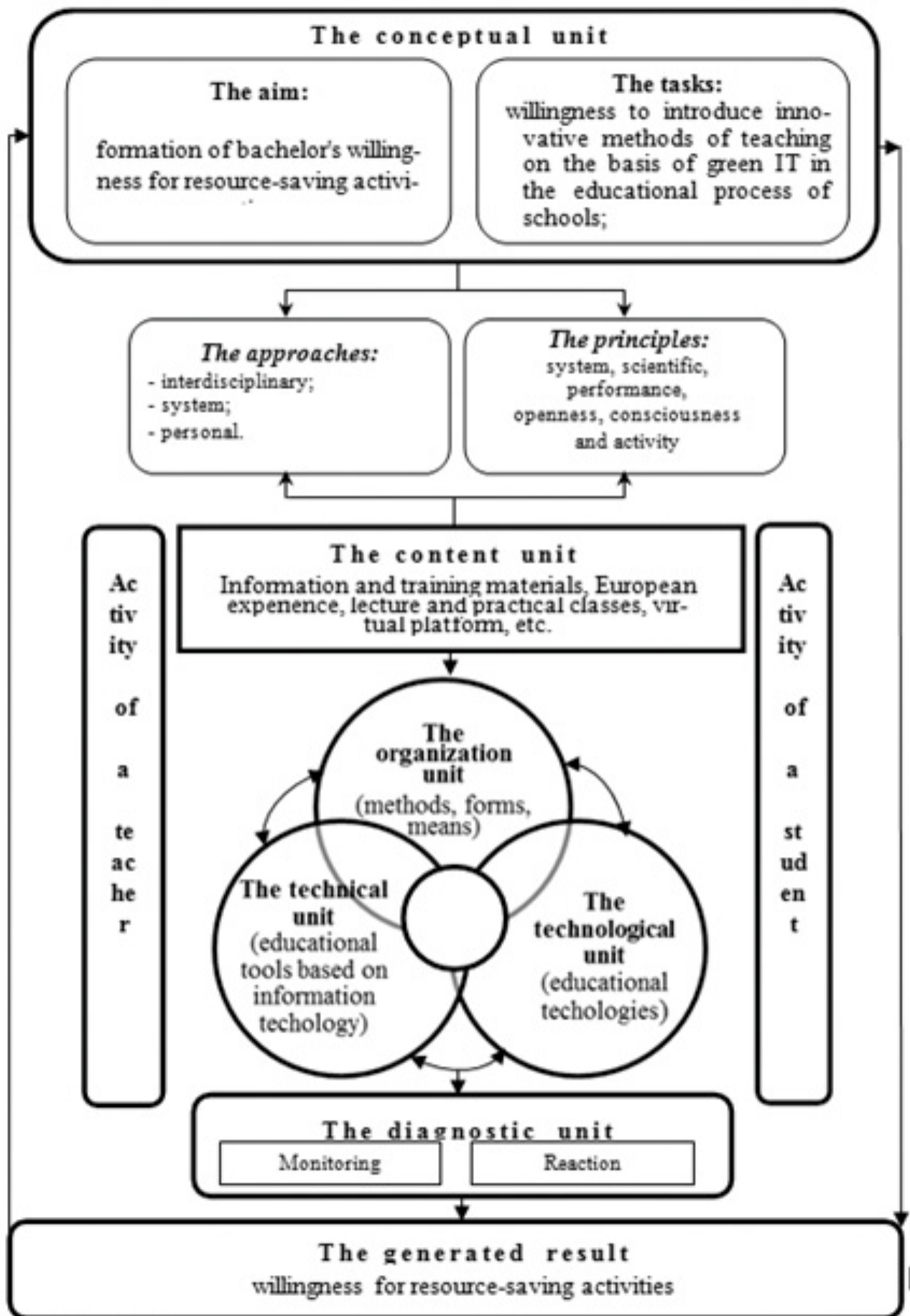willingness for resource-saving activities

Figure 1: Model of the computer science future teachers preparation for resource-saving activities